FIREFIGHTER II MOD C

Ropes and Knots

2-16 ROPES AND KNOTS

2-16.1 Identify the difference between life safety and utility ropes. (*3-1.1.1*)

2-16.2 Identify types of rope construction (*3-1.1.1, 3-1.1.2*)

2-16.3 Identify the following knots, their uses, and how they are constructed: (*3-1.1.1, 3-1.1.2*)

- **2-16.3.1** Bowline
- **2-16.3.2** Clove hitch
- **2-16.3.3** Figure of eight on a bight
- **2-16.3.4** Becket or sheet bend
- **2-16.3.5** Overhand safety
- **2-16.3.6** Half hitch
- **2-16.3.7** Figure of eight follow through

2-16.4 Identify the procedures for using a rope to tie ladders, hose and other objects to secure them. (*3-3.11)*

2-16.5 Identify the reasons for placing a rope out of service. (*3-1.1.1*)

2-16.6 Identify the method of marking a rope to remove it from service according to manufacturer's recommendations. (*3-1.1.1*)

2-16.7 Demonstrate tying the following knots, given the proper rope, and hoisting any selected forcible entry tool, pike, pole/hook ground ladder, hose line, extinguisher, or appliance to a height of at least twelve (12) feet: (*3-1.1.1(b), 3-1.1.2(b)*)

- **2-16.7.1 Bowline**
- **2-16.7.2 Clove hitch**
- **2-16.7.3 Figure of eight on a bight**
- **2-16.7.4 Becket or sheet bend**
- **2-16.7.5 Overhand safety knot**
- **2-16.7.6 Half hitch**
- **2-16.7.7 Figure of eight follow through**

2-16.8 Demonstrate the proper techniques for inspecting rope for the following: (*3-5.3(b)*)

- **2-16.8.1 Chemical damage**
- **2-16.8.2 Cuts and abrasions**
- **2-16.8.3 Internal damage**
- **2-16.8.4 Mildew and rot**
- **2-16.8.5 Stretch**
- **2-16.8.6 Thermal damage**

2-16.9 Demonstrate the proper cleaning and maintenance of rope.

2-16.10 Demonstrate the appropriate method(s) of rope storage.

2-16.11 Demonstrate using a rope to tie ladders, hose and other objects to secure them. (*3-3.11(b)*)

REFERENCES

IFSTA Essentials, 4th ed., Chapter 6
Delmar, Firefighter's Handbook, copyright 2000, Chapter 15
Jones & Bartlett, Fundamentals of Fire Fighting Skills, 1st ed., Chapter 9

2-16 Ropes and Knots

I. Identify the difference between life safety and utility ropes. **2-16.1** (*3-1.1.1*)

A. Life safety rope:

1. Must conform to NFPA1983, Standard on Fire Service Life Safety Rope and System Components
2. Definition: *Rope dedicated solely for the purpose of supporting people and/or victims during rescue, fire fighting, or other emergency operations, or during training evolutions.*

B. Utility rope

1. Can be used to hoist equipment, secure unstable objects, or cordon off an area.
2. Also needs to be inspected regularly for damage.

II. Identify types of rope construction. **2-16.2**

A. Types:

1. Laid: Twisting yarns together to form strands, generally three strands
2. Braided: Uniformly intertwining strands of rope. Similar to braiding one's hair.
3. Braid-on-braid: Braided core and braided cover or sheath.
4. Kernmantle: Jacketed rope; core with cover

a. Dynamic:

1) Used when long falls are possible.
2) Stretches to reduce the shock impact during a fall.
3) Not suitable for hauling

b. Static:

1) Low stretch rope
2) Good for most rescues
3) Designed for low stretch without breaking

B. Rope/knot technology

1. Running end: Used for hoisting, pulling or belaying
2. Working end: Forms the knot
3. Standing part: Between the working end and the running end
4. Bight: Bending the rope back on itself, sides parallel
5. Loop: Crossing the side of a bight over the standing part

    a. Make a bight and cross over the standing part

6. Round turn: Further bending one side of a loop

    a. Make a loop, continue bending one side of the loop until the sides are parallel

III. Identify the following knots, their uses, and how they are constructed: **2-16.3** (*3-1.1.1, 3-1.1.2*)

A. Bowline **2-16.3.1**

1. Shares a degree of acceptance in both life safety and other fire service applications.
2. Easily untied
3. Good knot for forming single loop that will not constrict the object it is placed around
4. Construction:

    a. Select enough rope to form the size of the knot desired
    b. Form an overhand loop in the standing part
    c. Pass the working end upward through the loop
    d. Pass the working end over the top of the loop under the standing part
    e. Bring the working end completely around the standing part and down through the loop
    f. Pull the knot snugly into place, forming an inside bowline with the working end on the inside of the loop.

B. Clove hitch **2-16.3.2**

1. Clove hitch consists of two half hitches
2. Principle use is to attach a rope to an object such as a pole, post or hoseline
3. Not regarded suitable for use in anchoring a life safety rope or in a life safety situation.
4. May be formed anywhere in the rope

5. When properly applied, it withstands a pull in either direction without slipping.
6. If knot subjected to repeated loading and unloading, it should be backed up with overhand safety knot.
7. Used for hoisting
8. Construction:

    a. Form a loop in your left hand with the working end to the right crossing under the standing part
    b. Form another loop in your right hand with the working end crossing under the standing part.
    c. Slide the right hand loop on top of the left hand loop. Note: This is the most important step in forming the clove hitch knot.
    d. Hold the two loops together at the rope forming the clove hitch
    e. Slide the knot over the object
    f. Pull the ends in opposite directions to tighten

C. Figure of eight on a bight **2-16.3.3**

1. Good way to tie a loop in either the middle or at the end of a rope.
2. Tied by forming a bight in either the end of the rope or at any point along its length, then tying a simple figure eight with the doubled part of rope.
3. Construction:

    a. Form a bight in the working end of the rope
    b. Pass it over the standing part to form a loop
    c. Pass the bight under the standing part and then over the loop and down through it; this forms the figure eight.
    d. Extend the bight through the knot to whatever size working loop is needed
    e. Dress the knot

D. Becket or sheet bend **2-16.3.4**

1. Used for joining two ropes of unequal diameters or joining a rope and chain.
2. Unlikely to slip when rope is wet.
3. Becket bend is not suitable in life safety applications
4. Construction:

    a. Form a bight in one of the ends to be tied (if two ropes of unequal diameter are being tied, the bight always goes in the larger of the two)
    b. Pass the end of the second rope through the bight
    c. Bring the loose end around both parts of the bight.

d. Tuck this end under its own standing part and over the bight
e. Pull the knot snug

E. Overhand safety **2-16.3.5**

1. As added safety measure of safety
2. Eliminates the danger of the end of the rope slipping back through the knot and causing the knot to fail.
3. Construction:

    a. Form a loop in the rope
    b. Insert the end of the rope through the loop
    c. Dress the knot by pulling on both ends of the rope at the same time

F. Half hitch **2-16.3.6**

1. Useful in stabilizing tall objects that are being hoisted.
2. Always used in conjunction with another knot or hitch.
3. Several half hitches can be applied in succession if required.
4. Construction:

    a. Make a round turn in the standing portion of the rope
    b. Slide the round turn down over the object being hoisted, making sure that the running end passes under the working end. (If necessary, on particularly long objects, such as pike poles, more than one half hitch can be used.)

G. Figure of eight follow through **2-16.3.7**

1. Used to tie ropes of equal diameter together or to tie a rope around an object when an end of the rope is not available.
2. Construction:

    a. Tie a figure eight knot on one end of the rope.
    b. Feed the running end of the rope through the figure eight knot in reverse. It should follow (hence the name) the exact path of the original knot.
    c. Use a safety knot, such as the overhand, with this knot.

IV Identify the procedures for using a rope to tie ladders, hose and other objects to secure them or hoist them. **2-16.4** (*3-3.11)*

A. Ladder

1. Starting at one end, secure the rope to a solid object (anchor) utilizing either a follow through figure eight or a figure eight on a bight, depending on the object being utilized as an anchor.
2. Lay the rope out, keeping it as straight as possible to minimize slack, until the other object to be tied to is reached. Come back down the standing part of the rope approximately 12 - 15 feet from this object and tie a figure eight on a bight resulting in a loop 6 - 12 inches long.
1. Wrap the running end of the rope around the object that it is being secured to and bring it to the figure eight on a bight tied in step 2.
2. Thread the running end through the loop and pull it back toward the object just wrapped around. Pull on the running end until the rope is sufficiently tight.
3. Using the running end, tie three or four consecutive half hitches around both sections of rope, which should be running parallel at this point.

B. Hose

1. Charged:

a. With the nozzle bale in the closed (forward) position, tie a clove hitch around the hoseline 18 - 24 inches behind the nozzle.
b. Form a bight in the rope and feed it through the bale from the coupling side, flipping it over before slipping it over the nozzle tip. You will have formed a half hitch by doing so.
c. Hoisting by this method, the rope will actually keep the nozzle closed.

2. Uncharged:

a. Fold the nozzle back on the hose approximately 3 - 4 feet.
b. Tie a clove hitch around the hose and nozzle to hold them together.
c. Place a half hitch around the end of the hose approximately 6 inches from where it is folded back.

C. Small equipment

1. Tie a follow through figure eight through the closed handle.
2. Use of a tag line is highly recommended for items of this type.

V. Identify the reasons for placing a rope out of service. **2-16.5**(*3-1.1.1*)

A. General

1. If rope is found to be worn
2. If rope is damaged on scene
3. Chemical damage/abrasions

B. Laid Rope

1. Check for:

a. Soft, crusty, stiff, or brittle spots
b. Areas of excessive stretching
c. Cuts, nicks or abrasions
d. Chemical damage
e. Other obvious flaws

2. Should be untwisted and checked internally for above.
3. Mildew does not indicate damage; clean and re-inspect.
4. Manila rope may have rot or mildew if foul smelling

C. Braided Rope

1. Visually inspect for exterior damage

a. Heat sears (caused by friction or fire)
b. Nicks and cuts
c. Excess or unusually fuzziness

2. Feel the rope for permanent mushy spots or other deformities

D. Braid-on-braid Rope:

1. Visually inspect for:

a. Heat sears
b. Nicks and cuts

c. Sheath sliding on core

1) If found, cut end of rope
2) Pull off excess material
3) Sear the end

2. Inspect for core damage

a. Lump may indicate core damage
b. Reduction in rope's diameter may indicate core is broken

3. Carefully examine for any type of damage or questionable wear to sheath.

E. Kernmantle Rope

1. Difficult because damage may not be obvious

a. Inspection can be performed by putting a slight tension on rope while feeling for lumps, depressions or soft spots.
b. Only way to determine whether a soft spot is damage or just temporarily miss-aligned core fibers is by carefully inspecting outer sheath.

1) Damage to outer sheath indicates probable damage to core.

2. Follow manufacturer’s recommendation s for testing integrity of interior kern (cord) of the rope
3. When in doubt about integrity, downgrade the rope to utility status.
4. Also inspect for

a. Irregularities in shape or weave
b. Mildew odor
c. Discoloration from chemical contamination
d. Roughness
e. Abrasions
f. Fuzziness

VI. Identify the method of marking a rope to remove it from service according to manufacturer's recommendations. **2-16.6** (*3-1.1.1*)

A. Removing ropes from service as Life Safety Rope

1. Per manufacturer's recommendation
2. Any rope that "fails" to pass inspection
3. Any rope that "fails" impact loading test

a. Impact loading testing must be entered into its logbook

B. Methods of removal

1. Disposing of rope
2. Removing manufacturer's label
3. Cutting rope into short lengths to be used as utility rope

VII. Demonstrate tying the following knots, given the proper rope, and hoisting any selected forcible entry tool, pike, pole/hook ground ladder, hose line, extinguisher, or appliance to a height of at least twelve (12) feet: 2-16.7 (*3-1.1.1(b), 3-1.1.2(b)*)

A. Bowline 2-16.7.1

1. Selects enough rope to form the size of the knot desired
2. Forms an overhand loop in the standing part
3. Passes the working end upward through the loop
4. Passes the working end over the top of the loop under the standing part
5. Brings the working end completely around the standing part and down through the loop
6. Pulls the knot snugly into place, forming an inside bowline with the working end on the inside of the loop.

B. Clove Hitch 2-16.7.2

1. Forms a loop in your left hand with the working end to the right crossing under the standing part
2. Forms another loop in your right hand with the working end crossing under the standing part.
3. Slides the right hand loop on top of the left hand loop.
4. Holds the two loops together at the rope forming the clove hitch
5. Slides the knot over the object
6. Pulls the ends in opposite directions to tighten

C. Figure Eight on a Bight 2-16.7.3

1. Forms a bight in the working end of the rope
2. Passes it over the standing part to form a loop
3. Passes the bight under the standing part and then over the loop and down through it
4. Extends the bight through the knot to whatever size working loop is needed
5. Dresses the knot

D. Becket or sheet bend 2-16.7.4

1. Forms a bight in one of the ends to be tied (if two ropes of unequal diameter are being tied, the bight always goes in the larger of the two)
2. Passes the end of the second rope through the bight
3. Brings the loose end around both parts of the bight.
4. Tucks this end under its own standing part and over the bight
5. Pulls the knot snug

E. Overhand safety knot 2-16.7.5

1. Forms a loop in the rope
2. Inserts the end of the rope through the loop
3. Dresses the knot by pulling on both ends of the rope at the same time

F. Half hitch 2-16.7.6

1. Makes a round turn in the standing portion of the rope
2. Slides the round turn down over the object being hoisted, making sure that the running end passes under the working end. (If necessary, on particularly long objects, such as pike poles, more than one half hitch can be used.)

G. Figure of eight follow through 2-16.7.7

1. Ties a figure eight knot on one end of the rope.
2. Feeds the running end of the rope through the figure eight knot in reverse. It should follow (hence the name) the exact path of the original knot.
3. Uses a safety knot, such as the overhand, with this knot.

H. Hoisting

1. Axe:

    a. Lowers a rope of appropriate length from the intended destination.
    b. Ties a clove hitch
    c. Slides the clove hitch down the axe handle to the axe head.
    d. The excess running end of the rope becomes the tag line.
    e. Loops the working end of the rope around the head of the axe and back up the handle.
    f. Ties a half hitch on the handle a few inches above the clove hitch.
    g. Ties another half hitch at the butt end of the handle.
    h. Hoists to a height of at least twelve feet.

2. Uncharged hoseline

    a. Lowers a rope of appropriate length from the intended destination.
    b. Folds the nozzle end of the hoseline back over the rest of the hose so that an overlap of four (4) to five (5) feet is formed.
    c. Ties a clove hitch, with an overhand safety knot, around the tip of the nozzle and the hose it is folded against, so that they are lashed together
    d. Places a half hitch on the doubled hose about twelve (12) inches from the loop end.
    e. With the ties properly placed, the hose will turn on the hose roller so that the coupling and nozzle will be on top as the hose passes over the roller.

3. Charged Hoseline

    a. Lowers a rope of appropriate size from the intended destination of the hoseline.
    b. Ties a clove hitch, with an overhand safety knot, around the hose about one (1) foot below the coupling and nozzle.
    c. Ties a half hitch through the nozzle handle and around the nozzle itself in a manner that allows the rope to hold the nozzle shut while it is being hoisted.

4. Pike Pole

    a. Lowers a rope of appropriate size from the intended destination of the pike pole.
    b. With the working end, makes a round turn around the object.
    c. Crosses the working end over the standing part and makes another round turn around the pike pole.
    d. Bring the working end under at the point he/she crossed with the first round turn. At this point, his/her round turns should be side by side with the standing part and loose end of the working end opposing one another.
    e. Finishes with a safety knot.

VIII. Demonstrate the proper techniques for inspecting rope for the following: 2-16.8 (*3-5.3(b)*)

A. Chemical damage 2-16.8.1
B. Cuts and abrasions 2-16.8.2
C. Internal damage 2-16.8.3
D. Mildew and rot 2-16.8.4
E. Stretch 2-16.8.5
F. Thermal damage 2-16.8.6
G. Inspection of a Laid Rope

1. Feels the rope for soft, crusty, stiff or brittle spots, excessive stretching and cuts, nicks or abrasions.
2. Visually checks the rope for cuts, nicks or abrasions or obvious flaws.
3. Untwists the rope if flaws are found to inspect the inside.
4. If mildew or foul smell is detected, rope should be untwisted.
5. Marks the rope out of service, if necessary

H. Inspection of a Braided Rope

1. Visually inspects the rope for heat sears, cuts, fuzziness
2. Feels the rope for permanent mushy spots
3. Marks the rope out of service, if necessary

I. Inspection of a Braid on Braid Rope

1. Visually inspects the rope for heat sears and cuts
2. Feels the rope for sheath sliding on the core, lumps and questionable wear
3. Marks the rope out of service, if necessary

J. Inspection of a Kernmantle Rope

1. Visually inspects the rope for cuts, fuzziness, irregularities in shape, damage to the outer sheath, and discoloration
2. Feels the rope for lumps, depressions, and soft, mushy spots.
3. Follows the manufacturer's recommendations for testing the integrity of interior kern (cord) of the rope.
4. Marks the rope out of service, if necessary.

IX. Demonstrate the proper cleaning and maintenance of rope. 2-16.9

A. Cleaning a natural fiber rope

1. Wipes or gently brushes the rope to remove grit and dirt.
2. Does not use water

B. Hand laundering a synthetic fiber rope

1. Wipes rope with a cloth or scrubs with a brush
2. Rinses
3. Dries

C. Cleaning a synthetic fiber rope using a rope washer

1. Feeds rope through washer
2. Rinses
3. Dries

D. Cleaning a synthetic fiber rope using a washing machine

1. Places rope in cloth bag, or "bird's nest coil" before washing
2. Washes
3. Dries

X. Demonstrate the appropriate method(s) of rope storage. 2-16.10

A. Coiling a rope for service

1. Selects enough rope at the loop end to make a tie around the coil when completed (usually about three times the distance between standards)
2. Wraps the rope around the standards until sufficient width is developed
3. Coils the rope in two layers to use a sufficient amount of rope.
4. Avoids making the coils too tight, which would make removal of the finished coil difficult

5. Coils the remainder of the rope around the loops
6. Fastens the end securely with a clove hitch
7. Ties the finishing tie to secure the coil
8. Does not store coiled rope with fuel cans or power tools.
9. Stores in clean, dry, well ventilated compartments.

B. Storage by bagging

1. Ties a figure of eight in each end.
2. With another person holding the bag, stuffs the rope in it.
3. Secures the bag
4. Does not store rope bag with fuel cans or power tools.
5. Stores in clean, dry, well ventilated compartments.

XI. Demonstrate using a rope to tie ladders, hose and other objects to secure them. 2-16.10 (*3-3.11(b)*)

A. Ladder

1. Starting at one end, secures the rope to a solid object (anchor) utilizing either a follow through figure eight or a figure eight on a bight, depending on the object being utilized as an anchor.
2. Lays the rope out, keeping it as straight as possible to minimize slack, until the other object to be tied to is reached. Comes back down the standing part of the rope approximately 12 - 15 feet from this object and tie a figure eight on a bight resulting in a loop 6 - 12 inches long.
3. Wraps the running end of the rope around the object that it is being secured to and brings it to the figure eight on a bight tied in step 2.
4. Threads the running end through the loop and pulls it back toward the object just wrapped around. Pulls on the running end until the rope is sufficiently tight.
5. Using the running end, ties three or four consecutive half hitches around both sections of rope, which should be running parallel at this point.

B. Hose

1. Charged:

a. With the nozzle bale in the closed (forward) position, ties a clove hitch around the hoseline 18 - 24 inches behind the nozzle.
b. Forms a bight in the rope and feeds it through the bale from the coupling side, flipping it over before slipping it over the nozzle tip. He/she will have formed a half hitch by doing so.

2. Uncharged:

a. Fold the nozzle back on the hose approximately 3 - 4 feet.
b. Tied a clove hitch around the hose and nozzle to hold them together.
c. Placed a half hitch around the end of the hose approximately 6 inches from where it is folded back.

C. Small equipment

1. Tied a follow through figure eight through the closed handle.